Ames, Langley, and Glenn Research Centers, and the Dryden Flight Research Center.

Phase I work for both projects has been completed and final reports submitted. Selection and award of the REVCON Phase II projects will be made by the end of FY01.

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Mars Exploration Using Vertical-Lift Planetary Aerial Vehicles

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Despite the thin, cold, carbon-dioxide-based atmosphere of Mars, recent work at Ames Research Center has suggested that vertical-lift planetary aerial vehicles (based on rotary-wing technology) could potentially be developed to support Mars exploration missions. The use of robotic vertical-lift planetary aerial vehicles would greatly augment the science-return potential of Mars exploration, but their development presents many technical challenges.

Why vertical-lift vehicles for planetary exploration? For the same reason that these vehicles provide such flexible aerial platforms for terrestrial exploration and transportation: their ability to hover and fly at low speeds and to take off and land at unprepared remote sites. Further, autonomous vertical-lift planetary aerial vehicles would have the following specific advantages and capabilities for planetary exploration:

- Hover and low-speed flight for aerial surveys
- Remote-site sample return to lander platforms, or precision placement of scientific probes
- Soft-landing capability for vehicle reuse and remote-site monitoring
- Greater range, speed, and access to hazardous terrain than a rover
- Better resolution of surface details than from an orbiter
- Could act as "astronaut agents"

Martian autonomous rotorcraft by their nature will have large lifting-surfaces and will be required to have ultralightweight construction. This in turn will pose a challenge in making them sufficiently robust to operate in the Martian environment. A number of vertical-lift aerial vehicle configurations for Mars exploration are being examined at Ames, including coaxial helicopters, quad-rotor helicopters, and tilt rotors (see fig. 1). Propulsion options include electric motors, powered by fuel cells or batteries, or an Akkerman hydrazine reciprocating engine.

Work to date has consisted mostly of conceptual design studies. NASA and Sikorsky Aircraft jointly sponsored the Year 2000 American Helicopter Society Student Design Competition for the design of a Martian autonomous rotorcraft. Excellent design proposals resulted from that competition. Many of the conclusions of the in-house work at Ames were supported by the independent design work done at the universities. Moreover, a considerable amount of enthusiasm was generated in academia and the industry for possible follow-on collaborative work.

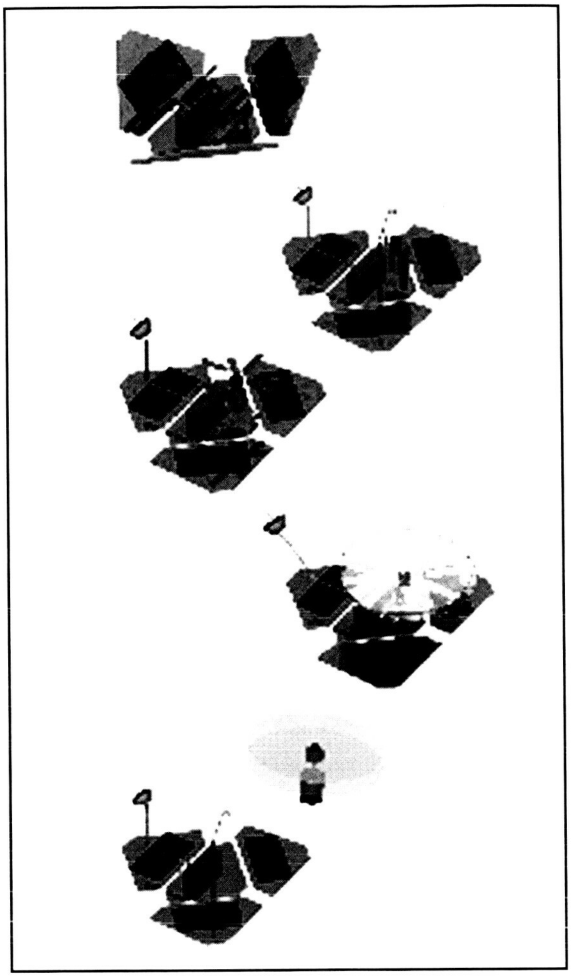

Fig. 1. National Mars Coaxial Helicopter.

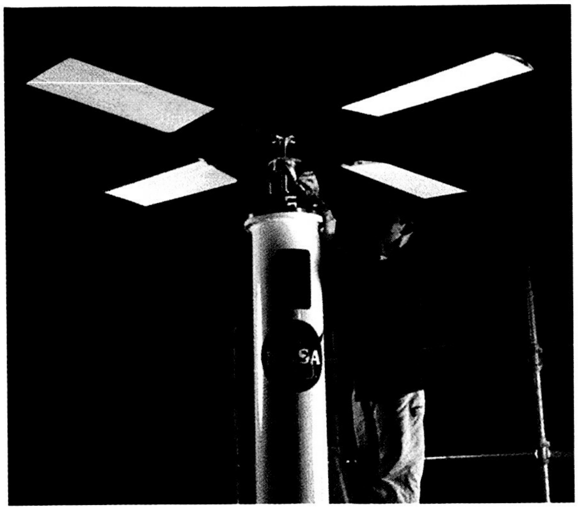

Fig. 2. Rotor and hover test stand for testing in simulated Mars atmosphere.

A baseline rotor and hover test stand for testing at Mars atmospheric densities has been developed (fig. 2). Initial proof-of-concept rotor hover testing will commence before the end of FY01.

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Ultrafast Beam Self-Switching by Using Coupled VCSELs

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The objective of this work was to develop directional beam switching through the use of two coupled vertical-cavity surface-emitting lasers (VCSELs). The simulation results show directional switching at a speed of about 40 gigahertz (GHz) and between directions about 8 degrees apart.

Dynamic beam switching of VCSELs has important applications for switching and routing in optical interconnect networks. VCSEL arrays of various kinds have been quite extensively researched for tailoring and engineering near- and far-field patterns. We propose a new method of directional beam switching by using two coupled VCSELs as follows. When two VCSELs are coupled by a small inter-VCSEL separation, and biased at the same steady current near threshold, then the resulting light output is dynamic at an